10/526856

DT15 Rec'd PCT/PTO 03 MAR 2005

SLEEVE, PROCEDURE FOR THE MANUFACTURE THEREOF AND MIXTURE FOR THE PRODUCTION OF SAID SLEEVE

FIELD OF THE INVENTION

This invention refers to exothermic sleeves for obtaining mini-deadheads applicable in the obtaining of cast pieces, especially in ductile iron, in the procedure for its production by blowing and curing and in the mixture which constitutes said sleeve.

BACKGROUND OF THE INVENTION

The production of cast metallic pieces comprises the pouring of the molten metal into a mould, the solidification of the metal by cooling and the de-moulding or extraction of the piece formed by means of the removal or destruction of the mould.

The moulds can be metallic or they can be formed by aggregates of different materials (ceramics, graphite and, mainly, sand). These moulds need to have some sprues or runners for communication between the internal cavity and the exterior, through which the molten metal is poured in the moulding or casting phase. Due to the contraction of the metal during the cooling process, some overflows have to be foreseen in the mould which are filled with reserve molten metal with the object of forming a deadhead intended to offset the contractions or cavities in the metal. The purpose of the deadhead is to feed the piece when the melt contracts in this, for which reason the metal has to remain in the deadhead in a liquid state for a longer period of time than the piece. For this reason, the deadheads are usually covered with some sleeves, consisting of insulating and/or exothermic materials, which slow the cooling of the metal contained in the deadheads in order to guarantee the fluidity thereof when cavity voids are produced in the cast metal.

The use of exothermic sleeves around the deadheads allows contraction problems to be reduced and the quality of the cast pieces to be

improved, which allows smaller deadheads (mini-deadheads) to be employed which improve production and reduce the contact surface of the deadhead with the cast piece, the elimination of which costs money.

Exothermic sleeves are known based on fibres manufactured in a wet process starting with a fibrous refractory material combined with a mixture of materials capable of producing an exothermic reaction constituted by an oxidizable metal, in which aluminium is habitually the most used, an oxidizing agent and a fusing agent or initiator of the exothermic reaction which, habitually, is a fluorinated compound. The oxidizable metal, when mixed with the oxidizing agent and the fusing agent and exposed to extreme heat, is oxidized liberating heat in proportion to the advancing reaction.

Exothermic sleeves are also known based on sand, highly appreciated in ductile iron foundries. The composition of these high-density sand-based sleeves contains a greater quantity of aluminium very high so that the amount of heat produced is very high. This heat is necessary to raise the temperature of the sand-based sleeve before favourably influencing the temperature of the metal in the deadhead.

In 1997 a fibre-free sleeve technology was introduced, furnishing a new alternative to the exothermic sleeves. The patent application WO 97/00172 discloses a procedure for blowing and cold box curing to manufacture dimensionally accurate, exothermic and/or insulating sleeves, based on a mixture blowable into a mould, said mixture consisting of microspheres of aluminium silicate with an alumina content of less than 38% by weight, a binding agent for cold box curing and, optionally, some non-fibrous loads. A typical composition for the production of exothermic sleeves comprises hollow microspheres with an alumina content of less than 38% by weight, aluminium powder, iron oxide and cryolite as fluorinated flux.

At the present time sleeves exist in the foundry industry for obtaining the so-called mini-deadheads, the function of which is also to feed liquid metal to the piece while the latter contracts during solidification.

The fundamental difference with the conventional exothermic sleeves is that the latter maintain the metal liquid for a longer time, whereby the volume of metal necessary, this is, the mini-deadhead, is smaller for a same feeding operation.

This result is achieved by increasing the exothermic load of the sleeve, but this increased exothermicity gives rise to undesired collateral problems, such as:

1. The excess of residual aluminium in the deadhead, which is later recast, gives rise to problems with pores in the molten pieces.

   The defect known as “fish-eye” is a surface flaw in the cast piece, originated by the accumulation of materials produced in the recovery of contaminated sand, fundamentally by the aluminium which is found in high proportions in exothermic sleeves.

   This defect can be overcome by the use of, for example, hollow microspheres of aluminium silicate with a low content of alumina, such as that described in WO 97/00172.

2. Degradation of the nodules in the area of contact of the sleeve with the piece which results in the rejection of pieces through non-compliance with the specifications for nodulation required by the client.

   This second problem is originated by the excess of fluorine proceeding from the fluorinated materials which are habitually used as initiating charge in the exothermic reaction.

   To avoid this problem, either the sleeve is not put in contact with the piece, which makes it necessary to use more metal, or an intermediate, fluoride-free biscuit is used, stuck to the mouth of the sleeve and having an equivalent central hole, which prevents contact of the actual sleeve with the piece. This biscuit, its

production and securing to the sleeve, signify a substantial additional expense.

SUMMARY OF THE INVENTION

The invention arises from the challenge of furnishing a sleeve for obtaining mini-deadheads which does not require the use of a fluoride-free biscuit, nor of any other element to avoid contact of the sleeve with the piece and which, moreover, produces in the deadhead a notch to facilitate its later separation from the cast piece and all this based on a blowable mixture, without fluorine, capable of producing an exothermic reaction for the provision of the heat required.

The starting point for this is, in the first place, blowing the mixture which will constitute the fluoride-free sleeve, into a mould which has two cores which, on one hand, will make possible the extraction of the sleeve once cured and, on the other hand, the obtaining of two orifices: one of them in the actual mouth of the sleeve, the orifice of which has a double interior circumferential chamfer, capable of producing an equivalent notch in the deadhead when the sleeve performs its function at the time of the casting. Another orifice in the base opposite the mouth, which will be closed, after the sleeve is cured, with a cheap material, because that area of the sleeve has no operational function in the casting process and only needs to be closed for the purpose of preventing sand or other undesirable materials from falling inside the deadhead.

This exothermic sleeve for obtaining mini-deadheads, is obtained by cold box blowing and subsequent curing of a fluoride-free mixture which comprises (a) hollow spheres of alumina silicate; (b) an exothermic material which comprises:

a) An insulating/ refractory material.
b) An oxidizable metal.
c) An oxidizing agent.
d) Magnesium as the reaction initiator element.

e) A catalyst purified in cold box.

Hollow microspheres of aluminium silicate are basically used as insulating material. Mixtures of these aluminium silicate spheres with sand can also be used, when it is necessary to improve the mechanical properties of the sleeve, to the detriment of the insulating properties.

As oxidizable metals aluminium, silicon and others can be used. Preferably aluminium in a combination of fine and coarse powder.

As oxidizing agents, nitrates, chlorates, permanganates and metallic oxides such as iron and magnesium oxide can be used and, of course, combinations of these compounds.

As initiator of the exothermic reaction, magnesium is used.

Once this mixture is blown into the mould, the sleeve extracted and cured, the orifice opposite the mouth is closed with a plug which can be made of plastic, wood, sawdust, sand, etc. and even of the same material as the sleeve.

The use of these sleeves allows the manufacture of high quality pieces, without degradation of the graphite nodules in the deadhead-piece contact zone, at reduced cost, comparatively less than that of other conventional procedures which deliver pieces of similar quality based on contact between the deadhead and the piece through an intermediate biscuit.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 illustrates the steps for the production of a sleeve by means of a conventional procedure of blowing and cold box curing pertaining to the state of the art. In this case, the mixture for the production of sleeves is blown into a mould (3) with the collaboration of a core (2) [Figure 1A]; next, the sleeve (1) is cured and de-moulded leaving the void intended for the deadhead (4) [Figure 1B]; and, finally, an intermediate biscuit (5) is applied

which has an orifice (6) for the melt to pass [Figure 1C].

Figure 2 illustrates the steps for production of an exothermic sleeve according to the procedure of blowing and cold box curing disclosed by the present invention.

DETAILED DESCRIPTION OF THE INVENTION

In one aspect, the invention is related with a procedure for the production by blowing and cold box curing of an exothermic sleeve for obtaining mini-deadheads which comprises:

(A) Introducing, by blowing, in a cold box curing mould, in the space defined between the mould and two cores which configure a double chamfer in the mouth of the sleeve, a blowable mixture, to obtain an uncured sleeve, open at both its ends, in which said mixture comprises:

a) a fluoride-free composition for the production of sleeves based on:

a.1) an insulating/refractory material.

a.2) an exothermic mixture which comprises an oxidizable metal and an oxidizing agent capable of producing an exothermic reaction, and magnesium as initiator material of the reaction.

b) a binding agent for cold box curing;

(B) Putting the uncured sleeve prepared in (A) in contact with a cold box curing catalyst;

(C) Leaving the sleeve resulting from (B) to cure;

(D) Removing the cured sleeve from the mould; and

(E) Locating a plug in the orifice opposite the mouth of the sleeve.

As can be appreciated in Figure 2, contrary to the conventional procedures pertaining to the state of the art (see Figure 1), in the procedure disclosed by this invention, the fluoride-free mixture for the production of exothermic sleeves is blown inside a mould, in the space defined between the mould (3) and the cores (2,2') [Figure 2A]. The cores (2,2') as well as allowing the subsequent extraction of the sleeve, produce a double chamfer (8) in the mouth thereof. When the sleeve (1) is cured, it is de-moulded leaving the void intended for the deadhead (4) [Figure 2B]; and, finally, a plug (9) is located in an open end of the sleeve (1) for the purpose of preventing sand or of any other undesirable element from entering inside the cavity intended for the deadhead during the casting operation [Figure 2C].

The double chamfer (8) of the sleeve, will produce in the deadhead a rut or slot equivalent in form which defines and facilitates the cutting line for the separation of the deadhead from the piece.

The insulating/refractory material (a.1) present in the fluoride-free composition for the production of sleeves is a material which basically comprises hollow microspheres of aluminium silicate, although it could also contain a certain quantity of sand, on the assumption that, by sacrificing insulating capacity, it is desired to improve the mechanical properties of the sleeve.

In general, the quantity of insulating/refractory material (a.1) will be between 30 and 70% by weight with respect to the total of the fluoride-free composition.

The exothermic material (a.2) present in the fluoride-free composition for the production of sleeves comprises an oxidizable metal and an oxidizing agent capable of producing an exothermic reaction, wherein said exothermic material comprises:

(i) magnesium as initiator element of the exothermic reaction, together with one or more oxidizable metals, preferably a mixture of powdered and granulated aluminium.

(ii) an oxidizing agent capable of reacting with the oxidizable metal and producing an exothermic reaction at the pouring temperature of the metal, said oxidizing agent being selected from the group formed by (a) salts of alkaline metals or alkaline earths, for example, nitrates, chlorates and permanganates of alkaline metals or alkaline earths; (b) metallic oxides, for example, iron and manganese oxides, preferably iron oxide; and (c) mixtures of (a) and (b). Said exothermic material (a.2) is in non-fibrous form, to be capable of being blown.

A property of the composition for the production of the exothermic sleeves according to the present invention resides in that said composition comes without the inorganic fluorinated flux habitually utilized as initiators of the exothermic reaction. Magnesium is used in place thereof, which reacts at a lower temperature whereby the exothermic reaction produced between the oxidizable metal and the oxidizing agent begins earlier.

The reaction between the oxidizable metal and the oxidizing agent is an exothermic reaction which produces heat thereby enhancing the heating properties of the exothermic sleeves. Thus, the loss of temperature is reduced of the molten material in the sprue, which is kept hotter and liquid for a longer time.

Depending on the level of exothermic properties it is desired to attain in the sleeve, the quantity of oxidizable metal present in the exothermic material (a.2) will be between 20 and 30% by weight with respect to the total of the fluoride-free composition for the production of the sleeve.

The procedure disclosed by this invention allows exothermic sleeves to be obtained with the desired balance of insulating and exothermic properties merely by using the quantities of insulating material (a.1) and of material exothermic (a.2) present in component A in the appropriate ratios by weight.

The cold box curing binding agents which can be used in the mixture for the production of sleeves according to the sleeve manufacturing procedure disclosed by this invention are known. In principle, any cold box curing binding agent can be used which is capable of maintaining the fluoride-free composition for the production of sleeves in the form of a sleeve and polymerise in presence of a curing catalyst. By way of example, use can be made of phenol resins, phenol-urethane resins, epoxy acrylic resins, alkaline phenol resins, resins of silicates, etc. activated by an appropriate catalyst in the gaseous phase. In a particular embodiment, this cold box curing binding agent is selected from among the epoxy acrylic resins activated by SO_2 (gas) and the phenol-urethane resins activated by amine (gas) known as cold box curing binding agents EXACTCAST® (Ashland).

The necessary quantity of cold box curing binding agent is the effective quantity to maintain the form of the sleeve and to permit its effective curing, that is, a quantity such as allows a sleeve to be produced which can be handled after the curing process. By way of example, the quantity of cold box curing binding agent will be between 1 and 10% with respect to the total of the composition for the production of the sleeve.

The catalyst for cold box curing is applied in gas form and is made to pass through the sleeve until the latter reaches a manageable consistency. The catalyst in the gaseous phase can be an amine, carbon dioxide, methyl formate, sulphur dioxide, etc. depending on the cold box curing binder utilized.

Operating appropriately and selecting the components of the composition for the production of sleeves, exothermic sleeves can be obtained with both internal and external dimensional accuracy, which can be coupled easily to the moulding assembly in the foundry after being manufactured with no need to carry out additional manipulations.

The exothermic sleeve obtainable according to the procedure disclosed by this invention constitutes an additional aspect of the present invention.

As can be appreciated in Figure 2, the sleeve (1) provided by this invention comprises:

(i) a body which surrounds the void intended to contain the deadhead (4) and which has a double chamfer (8) on the mouth thereof, and

(ii) a plug (9) in the base opposite the mouth.

The double chamfer (8) present in the sleeve provided by this invention is due to the combined action of 2 cores (2,2') during the blowing of the mixture. The double chamfer (8) will define in the deadhead a rut or slot which facilitates the separation of the same from the cast piece.

Due to the manufacturing procedure of the sleeve provided by this invention, which comprises the combined action of 2 cores, 2 open ends are produced. One of said ends contains a double chamfer (8) whilst the other open end is closed with a plug (9) for the purpose of preventing sand or any other undesirable element from passing into the interior of the sleeve during the mounting of the same on the mould and, of course, during the casting operation. Thus, said plug (9) has no structural purpose nor does it intervene in the formation or action of the deadhead, and, for this reason, the material used in the production of the plug can be practically any material, advantageously, a cheap material, such as plastic, wood, sawdust, paper, sand, etc., or even the actual material constituting the sleeve.

By way of comparison a table is provided below of blowable mixtures for obtaining exothermic sleeves with fluorinated and fluoride-free flux, according to the invention, for the same exothermal capacity.

COST OF THE MIXTURES FOR THE SAME DEGREE DE EXOTHERMICITY

	MINI-DEADHEADS WITH FLUORINE	MINI-DEADHEADS WITHOUT FLUORINE	MINI-DEADHEADS MADE OF SAND
	%	%	%
Microspheres	56.0%	54.0%	
Microspheres			
Aluminium, fine	22.0%	22.0%	22.0%
Aluminium, coarse	6.0%	6.0%	6.0%
Fe_3O_4-Magnetite	4.0%	4.0%	4.0%
Cryolite	4.0%		4.0%
KNO_3-Potassium nitrate	8.0%	10.0%	8.0%
Magnesium		4.0%	
Sand 60/70			56.0%
COST PER KILOGRAM OF MIXTURE	**100.0%**	**100.0%**	**100.0%**